

# The availability of unavailable information

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*Currently, developers of decision-support systems try to integrate these systems with the electronic medical record. The drawback is a limited amount of recorded medical data. System developers who face the choice between designing an integrated 'non-inquisitive' system and an integrated 'inquisitive' system need insight into the availability of information that is being missed by the support system. Therefore, we have investigated in a simulation study, the reasons why information that was being missed from the electronic medical records of patients with asthma/COPD by reviewers, had not been recorded by general practitioners. Important reasons were: the physicians had not recorded the information explicitly, they assumed the requested information to be common knowledge, and the information was available elsewhere in the electronic medical record. Also, we investigated the reasons why information that was being missed, could not be made available by the physicians. Important reasons were: the decision had been made by another decision maker, or the physician had not recorded the information at the time of the encounter. In addition to insight into the availability of missing information, system developers need to have insight into the significance of this information for the quality of the decision support, before the final choice between a non-inquisitive and an inquisitive design can be made.*

## INTRODUCTION

Over the past ten years, we have witnessed in Dutch Primary Care a shift from paper-based medical record to electronic medical record (1). The shift from paper to computer was motivated by a variety of issues, for example, readability and availability of medical information, support of general practitioners (e.g., preventive medicine), cost-containment, and research. Most general practitioner practices in The Netherlands are now fully automated for both administrative and medical data.

Parallel to the development of electronic medical records, researchers have attempted to develop decision-support systems, for example, MYCIN(2), QMR(3,4), de Dombal's Abdominal Pain(5),

ATTENDING(6), and HYPERCRITIC(7). Although many decision-support systems were built most failed to become incorporated into daily clinical practice (8,9). An important reason for this failure was that these systems tended to be stand-alone, requiring separate data entry(10,11). Researchers, therefore, have argued that decision-support systems need integration with electronic medical records (1,12,13). With *integration of decision-support systems with an electronic medical record* we denote both a physical integration (i.e., electronic medical record and decision-support system can be used on one workstation), and a functional integration (i.e., the physician performs his tasks from within one application environment and data from the medical record are available to the decision-support system).

The choice for an integration of decision-support systems with electronic medical records leads to the next problem: the support that can be given by a decision-support system is limited by the available medical data.

In the ideal situation, physicians record all relevant medical data in a structured, standardized fashion. Assuming that sufficient information for decision-support systems to perform their task would thus be available, we could build systems that do not request any additional data from the user – *non-inquisitive* systems (14). One of the advantages of such non-inquisitive systems is that physicians will only be interrupted to receive decision support.

On the other hand, when the quantity and quality of information recorded by the physician is insufficient for decision-support systems to perform their task, additional data would have to be requested, resulting in *inquisitive* systems. An inquisitive system interrupts the physician to ask for additional data, thereby perhaps introducing a stumble block to its acceptance.

Before a choice can be made between a non-inquisitive system and an inquisitive system, system developers need to know how much of the information required by the decision-support system, is missing (14). In addition, they need to know how much of the missing information would be available when requested. Only when the physician is able to

answer the requests of an inquisitive system, will such an inquisitive design be useful.

We are developing a decision-support system that will support general practitioners with the diagnosis and therapy of patients with asthma/COPD. The system reviews the physician's electronic medical records and, when applicable, generates critiquing comments. To optimize the system's chances for incorporation into the physician's daily routine, we prefer to build a non-inquisitive system. We investigated how much and which kind of information was missed from medical records by reviewers for a *reviewing task* (14). We also gained insight into the amount of missing information that was available when requested. In the present study, we investigate why information that was available upon reviewers' request, had not been recorded by general practitioners. Also, we investigate why information was not available upon request.

## METHODS

We selected six electronic medical records of patients with asthma/COPD from three general practitioners. These general practitioners use ELIAS, an information system for general practitioners widely used in The Netherlands. We printed the medical records, and asked four reviewers (experts in asthma/COPD – two pulmonologists and two general practitioners) to identify from these medical records missing information that would be needed to critique the general practitioner's diagnostic and therapeutic interventions. We asked the reviewers to write down their requests for additional information in free text. The reviewers worked independently. As a result, different reviewers sometimes requested identical information using slightly different wording. We mapped these requests from more than one reviewer to a single request.

Next, we asked the general practitioners to provide the requested information. When the information was available, they were asked to state why it had not been recorded. When the requested information was not available, we asked the general practitioners to state why they could not provide it. The general practitioners provided the requested information in free text.

### Analysis

We divided the requests for additional information into the following three categories. Two categories of requests dealt with missing facts, one category dealt with missing reasoning:

*Factual patient data:* These were requests dealing with missing factual data about the medical history,

physical exam, diagnosis, or additional tests (for example, "What did the pulmonary physical examination reveal?");

*Factual therapeutic data:* These were requests dealing with the physicians' therapeutic interventions (for example, "What was the exact number of prescribed tablets?");

*Motivation:* These were requests dealing with missing information about the general practitioners' motivation for their policy (for example, "Why did the physician change the medical device?").

### Available information

When the general practitioners were able to provide the requested information, we divided the reasons that they provided for not having recorded the requested information in the medical record as follows:

*Not explicitly recorded:* The physician had not recorded the requested information explicitly. However, he could answer the request based on the recorded data. For example, when asked for the reason why he had changed the prescribed bronchodilating agent, a physician stated that the recorded symptoms indicated to him that the previously prescribed bronchodilating agent had not been effective enough;

*Assumed to be known:* The requested information was assumed to be common knowledge. For example, 'fever means a temperature above 38.0°C';

*Recorded elsewhere in the electronic medical record:* The requested information had been recorded elsewhere in the electronic medical record. For example, when using an information system, general practitioners develop their own 'shorthands' (e.g., tags), not necessarily understood by others. For example, smoking was not coded in the medical record, but recorded as a tag in the electronic medical record;

*Registered in paper-based record:* Due to the amount of work involved with the transition from the paper-based medical record to the electronic medical record, not all medical data had already been recorded in the electronic medical record. The information was, however, available in the paper-based record. This cause for information to be absent from the record, is temporary.

*Other source:* The information was obtained after the request had been received. For example, it was obtained from a family member who happened to pay the physician a visit.

### Unavailable information

When the general practitioners could not provide the requested information, we divided the reasons as follows:

**Other decision-maker:** The general practitioner indicated that the decision had been made by another authority. In The Netherlands, general practitioners are organized into small groups working together in some geographical area. The practitioners in such groups will, for example, take shifts in caring for one another's patients at nights, during weekends, and in vacations. In this way, sometimes decisions about patients are made by another decision-maker, i.e., by the general practitioner on call;

**Information not known:** The physician neither knew the answer to the request, nor did he know where to locate the missing information. For example, specific symptoms at the time of the encounter;

**Too much effort required:** The physician knew where to find the information, but had not taken enough effort to get it. For example, the information was only available in the paper-based record;

**Request unclear:** The request could not be answered because it was unclear to the physician.

## RESULTS

The four reviewers requested 132 times additional information on 87 visits. We mapped these 132 requests to 90 single requests.

Of these 90 requests, 44 dealt with *Factual patient data* (49%), 24 requests dealt with the physician's *Motivation* (27%), and 22 requests dealt with the physician's *Factual therapeutic data* (24%). Of these 90 different requests, the general practitioners were able to provide information in 58 of the cases (64%). In the remaining 32 of the cases (36%), they were not able to do so.

### Available information (N=58)

The frequency of the reasons why the general practitioners had not recorded requested information that they had available, are presented in Table 1.

Table 1 Reasons why information that was available when requested (N=58), had not been recorded in the medical record.

Frequency (%)	Reason
31/58 (54%)	Not explicitly recorded
13/58 (22%)	Assumed to be known
10/58 (17%)	Registered elsewhere in the electronic medical record
3/58 (5%)	Registered in the paper-based record
1/58 (2%)	Other source

In 54% of the answered requests, the physician indicated that the requested information was not explicitly recorded in the medical record. In 22%, the

requested information was assumed to be known. In 17% of the cases, the requested information had been recorded elsewhere in the electronic medical record. In 5% of the cases, the information had not been recorded in the electronic medical record yet, but had been available in the paper-based record. Finally, in 2%, the information was provided by an external source.

### Unavailable information (N=32)

The frequency of the reasons why the general practitioners had not been able to provide the requested information are presented in Table 2. In 41% of the cases in which requested information had not been available, the general practitioner indicated that the decision had been made by another authority. In 37%, the physician did not know the answer to the request, nor did he know where to locate the missing information. In 19% of the cases, the physician knew where to find the information, but had not taken the effort to retrieve it. In 3%, the request could not be answered because it was unclear to the physician.

Table 2 Reasons why requested information was unavailable (N=32)

Frequency	Reason
13/32 (41%)	Other decision-maker
12/32 (37%)	Information not known
6/32 (19%)	Too much effort required
1/32 (3%)	Request unclear

## DISCUSSION

System developers face a choice between a non-inquisitive and an inquisitive system design when integrating their decision-support system with an electronic medical record. When data missing from the electronic medical record can be made available, it can be important for a decision-support system to try to obtain these data. In such cases, the design of an inquisitive system could be useful. On the other hand, when missing data are unavailable, it is very unlikely that the design of an inquisitive system could be useful. In addition, the kind of data that are to be obtained may also influence the design of an inquisitive system. Therefore, we investigated the reasons why information that had been missed from electronic medical records by reviewers for a reviewing task, and that was available upon request, had not been recorded. We also investigated the reasons why information was unavailable upon request by the reviewers.

In about two-thirds (64%) of 90 requests for additional data, the general practitioners could provide additional information. This indicates that the

general practitioners do not record all that they know about their patients.

Why had *available information*, requested by the reviewers, not been recorded in the medical record? Most frequently (54%), the general practitioners indicated that the requested information dealt with information that they normally do not record explicitly, such as their motivation for a particular choice of therapy. In other words, information on a physician's reasoning is often recorded implicitly, and only available when it is asked for. For decision-support systems that require this kind of information, the design of an inquisitive system may be unavoidable. For example, Vlug and van der Lei tried to use the information that physicians normally record in their electronic medical records for the purpose of post-marketing surveillance. They discovered that there were insufficient data. Vlug and van der Lei reported the necessity to add modules to an electronic medical record that asked for, among other data, information on the physician's motivation(15).

Some of the requested information turned out to be available elsewhere in the electronic medical record (17%). For example, information had been recorded as a tag (not necessarily understood by others). In other cases, the information was assumed to be known by the readers of the medical record (22%). These two causes of omitted registration illustrate some of the consequences of current limitations in the organizational structure of medical data in electronic medical records. Some of these limitations can be overcome by electronic medical records that support the structured data entry of a broader range of factual medical data. When data would be entered in a uniformly structured fashion, tags may still be used, but the underlying information will be available for review. Information that is assumed to be common knowledge, such as 'fever', would have to be defined the first time that it is used. Thereafter, the term would never constitute interpretation problems anymore when viewed at any user's level of definition (e.g., the conceptual level of 'fever' or 'a temperature of 38.0°Celcius'). The challenge that systems of this level of sophistication have to face is to try to combine complexity with clarity and ease of use (16).

In 3 out of 58 cases, the general practitioners mentioned the transition from paper-based record to electronic medical record (5%). When the amount of medical data that is needed by a decision-support system, suffers from a significant transcription backlog, a (temporary) module asking for historic data may be necessary. The frequency that we found may not be representative for medical records of

patients with pathology different from asthma/COPD. We reviewed records of patients with asthma/COPD, which is a chronic disease, requiring regular follow-ups and stimulating the physician to have this kind of records on-line completely.

Why was *information*, requested by reviewers, *unavailable*?

The reason that was mentioned most often was that the decision about which additional information had been requested, had been made by another decision maker than the patient's own general practitioner. Therefore, the general practitioners could not provide the requested information. We think that this observation may illustrate the fact that in Dutch health care (even though general practitioners function as gatekeepers), a single patient receives care from an increasing number of different health care workers, as is true for most Western countries. This change in health care from a low number of caregivers to a high number, creates a need for a better management of health-care information. For example, a better exchange of information across health-care settings could be possible by the application of electronic communication (17).

For our system, there are reasons to choose an inquisitive design. Much information that is missed by reviewers from medical records of patients with asthma/COPD, is available from the physician (either from his memory or from the paper-based record). When we would choose a non-inquisitive design, some additional information can be obtained from the electronic medical record itself by additional programming. When the amount of factual medical data that thus can be obtained is insufficient for our purpose, the choice for an inquisitive design would be unavoidable.

However, at this moment, we do not know what the significance of the missing information is for the quality of the decision-support system. In another report on our study, we describe the impact of the available requested information on the number of comments generated by the reviewers. The reviewers left the majority of comments unchanged(14). When we put it the other way, the reviewers changed a minority of comments after the requested information had been provided. The significance of this relatively small number of changed comments for the quality and effectiveness of the decision-support system is as yet unclear. For our system, AsthmaCritic, we have, therefore, chosen a non-inquisitive design. The system will only automatically try to acquire some missing data. In our further studies, we will evaluate the significance of information that will thus not be obtained.

In general, we feel that the final decision for a (non-)inquisitive design of a decision-support system can only be made when:

- 1) The *extent* to which required information is missing from the data source is clear;
- 2) The *availability* of missing information is investigated;
- 3) The impact of available requested information on the *quality* of the decision-support is investigated;
- 4) The impact of available requested information on the acceptance and *effectivity* of the decision support has been evaluated.

## CONCLUSIONS

Much of the information missed from the medical record of patients with asthma/COPD by reviewers, is available. For decision-support systems, some of the missing information that became available, can only be obtained by asking the physician. A system that needs this kind of information requires an inquisitive design. Other missing information that became available, can be obtained from a different location in the electronic medical record, and may be obtained by the decision-support system itself. A system that needs this kind of information, could be non-inquisitive. The missing information that did not become available, will only be obtained when electronic medical records that support the structured entry of a broader range of medical data, or that support a better exchange of medical data among health care workers, will have been developed.

Before system developers who face the choice between a non-inquisitive design and an inquisitive design can make a final decision, they also need to have insight into the significance of available missing information for the quality and effectiveness of the decision support.

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